M.E. (Water Resources & Hydraulic Engg.) Examination (6 Semester), 2024

(3rd Semester)

WATER RESOURCES MANAGEMENT

(Paper - VIII)

Time: Three Hours | Full Marks: 100

Answer any ***four*** questions

1. (a) Determine the shortest route for a pipe line and maximum benefit from among various possible routes available from destination to source as shown in figure using dynamic programming method. All nodes points are Stand post for water distribution. All values are given in km as pipeline distribution network.

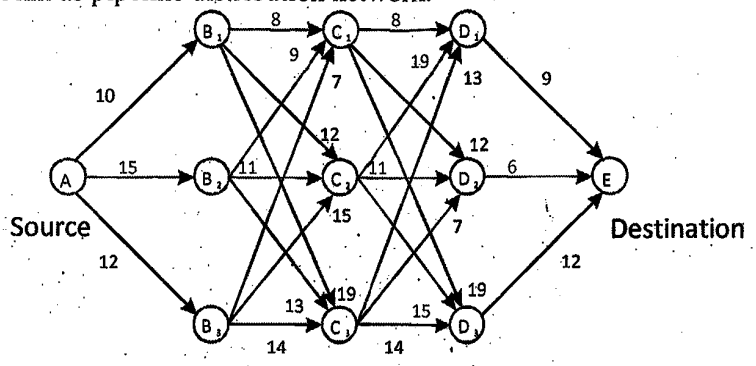

Fig: Network of routes

(b) Identify the key elements of Integrated Flood Management in the context of an Integrated Water Resource Management.

20+5=25

2. (a) Define drought. Classify different types of drought with scales.

(b) A farm, measuring 800 ha, has 10 million cubic metres of water available annually. Two crops, crop 1 and crop 2, are considered for which annual irrigation water depth requirements are 1.2 m and 0.8 m, respectively. For various reasons, no more than 400 ha can be planted in crop 1, and no more than 600 ha can be allocated for crop 2. Estimated profits are Rs. 3000 per ha planted in crop 1 and Rs. 5000 per ha planted in crop 2. Formulate a linear programming model and solve it, using Graphical method, determine how many hectare (ha) to plant in each crop to maximize profits.

(c) There are three types of roof in the office building namely administrative building roof, car park with RCC roof and cycle stand with asbestos roof having individual areas 600 m^2, 350 m^2 and 200 m^2 respectively. The average rainfall is considered as 1650 mm in Kolkata. Assume rate of filtration = 2050 Lt/hr/m^2; average recharging depth = 50 m; Length and diameter of strainer = 30 m and 200 mm. Estimation of total water available that could be harvested (both rainy and non-rainy season) and also design RTRWH and recharging with sketches.
{No of Rainy days= 120 days (80% of the rainfall considered to be occurred during rainy days and 20% in other days of the year); Occurrence of rainfall during monsoon = 80%; Rainfall to be harvested from the rooftop after allowing the diversion of the first rain= 80%}. Assume any other data if needed.

3+10+12=25

3.(a) Distinguish between bed load, suspended load and wash load.

(b) State two empirical equations for the soil loss due to Sheet and Rill erosion and describe them with each parameter. State two functions of trap efficiency.

(c) What are the factors affecting erosion? Differentiate between Rill erosion and Gully erosion.

(d) A reservoir has a capacity of 6.0 Mm^3 and a drainage area of 250 km^2. The average annual runoff is 400 mm and the sediment yield is 1250 t/km^2. The sediment has an average in place. Sp.wt. of 1500 kg/m^3. Find the time required to reduce the reservoir capacity to 2.0 Mm^3. Adopt a uniform volume increment of 1 Mm^3. The trap efficiency (Y) of the reservoir may be assumed as given below. What is the percentage error on your answer if a single increment is used in calculations?

C/I	0.055	0.045	0.035	0.025
Y	78.5	75.5	71.0	64.0

$$Y=100\{1-\frac{1}{100x+1}\}^{1.5}$$

3+5+5+12=25

4. (a) Define uncertainty. What are the different types of uncertainties in Water Resources Engineering Projects? What is hydrologic and hydraulic uncertainty? Classifies different uncertainty in brief with an examples.

(b) Determine the mean and standard deviation of discharge in cumec and coefficient of variation and the following parameter values for discharge using the Chezy's equation and deduce the equation.

Parameter	Mean	Coefficient of variation
S	0.8 %	0.006
D	1500 mm	0.10

$$Q = A * C\sqrt{(R * S)}$$

Where C= 150 for PVC pipe, A is the cross sectional area of circular section, R is the hydraulic radius, S is the slope of water surface and Q is in m^3/s. consider D and S are uncertain.

(c) The flow rate Q for a Triangular-Weir can be expressed as

$$Q = \frac{8}{15} C_d \tan(\frac{\theta}{2}) \sqrt{2g} H^{\frac{5}{2}}$$

where, C_d = Co-efficient of discharge, H= head of the weir. The variable H is subjected to be uncertain. The mean and coefficient of variation are as follows,

Parameter	Mean	Co-efficient of variation
H	2.5 m	0.82

Use first-order uncertainty analysis, to estimate the mean, Coefficient of variation and standard deviation of Q using C_d =0.90, apex angle, $\theta=90^0$

6+12+7=25

5. (a) Give an explanation briefly how a water resource project proposal is analyzed on the basis of the cost-benefit method.

   (b) Derive a relationship between present worth (P) and capital recovery factor where A is capital recovery, F is the future sum of money at the end of the n^{th} year and i is the interest rate per annum (expressed as a decimal fraction).

   (c) Two mutually exclusive alternative water supply projects are given below:-

	Project A	Project B
	(Rs in 1000)	(Rs in 1000)
Construction Cost	40000	30000 1st stay 42000 2nd stay
Operation & Maintenance Cost	160 / year for 40 years	120 / year for 1st 20 years 200 / year for 2nd 20 years
Economic Life	40 years	40 years
Period of Analysis	30 years	30 years
Annual Benefits	2500	2800
Discount Rate	6%	6%

   Which is the more economic project?

4+3+18=25

6. (a) What is the importance of probability and statistics in water resources engineering and management?

   (b) Briefly define risk, reliability and safety factors in water resources management.

   (c) A water resources project has an expected life of 20 years. (i) For an acceptable risk of 5% against the design flood, what design return period is to be adopted? (ii) If the above return period is adopted and the life of the structure can be enhanced to 50 years, what is the new risk value?

   (d) Analysis of the annual flood peak data of river Damodar at Rhondia, covering a period of 21 years yielded a mean of 8520 m^3/s and a standard deviation of 3900 m^3/s. A proposed water control project on this river near this location is to have an expected life of 40 years. Policy decision of the project allows an acceptable reliability of 85%.

   (i) Using Gumbel's method recommend the flood discharge for this project.

   (ii) If a safety factor for flood magnitude of 1.3 is desired, what discharge is to be adopted? What would be the corresponding safety margin?

Reduce Mean $\overline{y_n}$ s the Gumbles Extreme value distribution

N = sample size

N	0	1	2	3	4	5	6	7	8	9
10	0.4952	0.4996	0.5035	0.5070	0.5100	0.5128	0.5157	0.5181	0.5202	0.5220
20	0.5236	0.5252	0.5268	0.5283	0.5296	0.5309	0.5320	0.5332	0.5343	0.5353
30	0.5362	0.5371	0.5380	0.5388	0.5396	0.5402	0.5410	0.5418	0.5424	0.5430
40	0.5436	0.5442	0.5448	0.5453	0.5458	0.5463	0.5468	0.5473	0.5477	0.5481
50	0.5485	0.5489	0.5493	0.5497	0.5501	0.5504	0.5508	0.5511	0.5515	0.5518
60	0.5521	0.5524	0.5527	0.5530	0.5533	0.5535	0.5538	0.5540	0.5543	0.5545
70	0.5548	0.5550	0.5552	0.5555	0.5557	0.5559	0.5561	0.5563	0.5565	0.5567
80	0.5569	0.5570	0.5572	0.5574	0.5576	0.5578	0.5580	0.5581	0.5583	0.5585
90	0.5586	0.5587	0.5589	0.5591	0.5592	0.5593	0.5595	0.5596	0.5598	0.5599
100	0.5600									

Table 7.4 Reduced Standard Deviation S_n in Gumbel's Extreme Value Distribution

N = sample size

N	0	1	2	3	4	5	6	7	8	9
10	0.9496	0.9676	0.9833	0.9971	1.0095	1.0206	1.0316	1.0411	1.0493	1.0565
20	1.0628	1.0696	1.0754	1.0811	1.0864	1.0915	1.0961	1.1004	1.1047	1.1086
30	1.1124	1.1159	1.1193	1.1226	1.1255	1.1285	1.1313	1.1339	1.1363	1.1388
40	1.1413	1.1436	1.1458	1.1480	1.1499	1.1519	1.1538	1.1557	1.1574	1.1590
50	1.1607	1.1623	1.1638	1.1658	1.1667	1.1681	1.1696	1.1708	1.1721	1.1734
60	1.1747	1.1759	1.1770	1.1782	1.1793	1.1803	1.1814	1.1824	1.1834	1.1844
70	1.1854	1.1863	1.1873	1.1881	1.1890	1.1898	1.1906	1.1915	1.1923	1.1930
80	1.1938	1.1945	1.1953	1.1959	1.1967	1.1973	1.1980	1.1987	1.1994	1.2001
90	1.2007	1.2013	1.2020	1.2026	1.2032	1.2038	1.2044	1.2049	1.2055	1.2060
100	1.2065									

3+3+9+10=25

7. (a) Define the term Transboundary Water Resources Management?
   (b) Briefly describe the different types of Multi Criteria Decision Making Methods.
   (c) Compute Lp – metric values of alternatives and corresponding ranking pattern for the payoff matrix presented in below Table using Compromise Programming method for p = 1, 2. Assume equal weights for each criterion. Alternatives A_1 to A_6 in payoff matrix represent hydropower projects and criteria C_1 to C_6 correspond to manpower, Hydropower (MW), construction cost maintenance cost, number of villages to be evacuated and security level respectively. Assume necessary data.

Payoff matrix

Crit / Alt	C_1	C_2	C_3	C_4	C_5	C_6
A_1	80	91	6	5.4	8	5
A_2	64	59	3	9.7	1	1
A_3	82	61	4	7.2	4	7
A_4	41	80	10	7.5	7	10
A_5	52	72	6	2.0	3	8
A_6	94	96	7	3.6	5	6
Max/Min	Min	Max	Min	Min	Min	Max

3+4+18 =25